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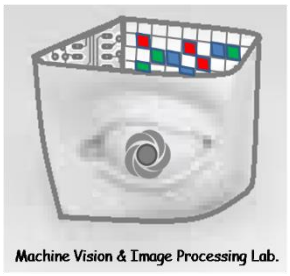
Digital Image processing

CHW4

Due: 1399/03/03



In this lab assignment you will learn some of the main applications of Wavelet transforms for image processing. You can use MATLAB Wavelet Toolbox or PYTHON pywt library but only functions for 1D processing. Thus, it is not allowed to use functions for 2D analysis like dwt2/idwt2 as part of the exercise is that you implement them yourself.

2D Wavelet Subband Coding:

a- Select a test image and display it. (Optional) Repeat this assignment with different test images.

```
fig = plt.imread("boat.png") # we know this image is grayscale so we grab first color
plt.imshow(fig, cmap='gray')
plt.title('fishingboat-Original',fontsize=12)
plt.axis('on')
plt.show()
```

b- Plot the low/high decomposition and reconstruction filters for Daubechies 8-tap (aka db4) wavelet transform. You can obtain the Daubechies coefficients using the function wfilters in MATLAB or pywt.families in PYTHON. This is the wavelet transform you should use for all the remaining tasks.

```
for family in pywt.families():
    print("%s family: " % family + ', '.join(pywt.wavelist(family)))
```

c- Implement a 2D wavelet and inverse 2D wavelet transforms using 1D wavelet transforms. It should have the following interface:

y2d = wt2d(x2d, Lo D, Hi D, nlevels)

x2d = iwt2d(y2d, Lo R, Hi R, nlevels)

where x2d is the input image, Lo D and Lo R are the 1D low-pass approximation filters while Hi D and Hi R are the 1D high-pass detail filters for decomposition and reconstruction, respectively. The number of desired scales is specified by nlevels. (The encoded signal y2d should have the standard layout, having approximation at the top-left block and the detail coefficients around it). To test, run a 3 level decomposition and

reconstruction of the selected test image. Verify how well is the image reconstructed by computing the mean absolute error between the original and the reconstructed image.

d- Decompose and reconstruct the image using the approximation coefficients only. Perform this for 3 progressively larger levels. Visualize the original image and the three reconstructed images, side by side.

2D Wavelet Denoising:

a- Add Gaussian noise ($\mu = 0$, $\sigma = 10$) to the original test image. Visualize both images (the original and its noisy version) side by side. Compute peak signal to noise ratio (PSNR) between the two images.

b- (Bonus=+0.5 points to this coputer assignment) Perform Wavelet decomposition and thresholding the detail coefficients in the following way:

- Select a threshold $T = \sigma\sqrt{2\log(n)}$, where n is the number of the detail coefficients and σ is an estimate of the noise level.
- Set all detail coefficients with their absolute value < T to zero.
- Reconstruct the image.

c- Compute the PSNR for different decomposition levels and σ values, i.e., for decomposition levels $\{1,2,3\}$ and values of $\sigma = \{1,10,100\}$.

Submission:

You need to submit a short report in PDF, and one MATLAB/PYTHON function for each task and a documented script that sequentially performs the implemented tasks, all in the same zipped folder. Feel free to implement any other auxiliary functions. Please write your name and Student ID on the top of each file as well as the PDF report.

Some test images are attached to this assignment.

با آرزوی قبولی عبادات و التماس دعا در شبهای قدر